Interim Report
to
Hon. Federico Mayor, Director-General
United Nations Educational, Scientific, and
Cultural Organization
Recommendations to UNESCO

I. Internet Connectivity

Working towards the assurance for all scientists of basic and affordable Internet connectivity should be UNESCO's first priority.

The Internet is a set of protocols that makes possible a "network of all networks" and allows all computer networks in the world, and their individual users, to communicate with one another. Compared with older systems of communication the Internet protocols also are remarkably efficient and allow many users to share single transmission lines. Today, a wide range of communications media (e.g., text, numerical data, audio, graphical and video images) also can be transmitted over the Internet in compact digital representations.<1>

Nor is the present Internet technology - impressive as it has recently become - a fixed achievement. Each of the components of the emerging global Internet continues to improve rapidly, sometimes exponentially. For example, a new generation of microprocessor chips for desktop PCs emerges every 18 months, with an order-of-magnitude increase in processing capacity; this trend seems likely to continue. Networks of fiber optic cable are, themselves, increasing in capacity at a rapid pace; several low-earth-orbit satellite networks providing broadband packet cellular technology appear likely before the end of the decade. Etc.

As a result of the Internet and the technology it represents, individual scientists can now routinely query databases anywhere in the world; two scientists can "talk" by text messages or exchange preprints of articles quickly and inexpensively with brief keystrokes; and new capacities for research colloquia or courses that are not geographically constrained, or simultaneous videoconferencing by teams of scientists, are among the capabilities that are being developed. Soon, the best and latest scientific data, ideas and teaching resources worldwide, can be quickly and inexpensively available on the desktops of researchers, students, government officials, and corporate engineers in every country.

The Internet is now emerging as a principal vehicle for new resources for working scientists. It also allows scientists and scientific institutions to share and use resources more efficiently on a global scale. And it provides a foundation for a genuinely global scientific community: scientists in developed countries and scientists in underdeveloped countries can work together easily; scientists in underdeveloped countries can work more readily within and between regions.

Full Internet connectivity also is an investment that can provide great leverage and contribute to many institutions and goals: the research productivity of scientists and the rate of scientific innovation; scientific education and training; technology transfer for agriculture and industry; the rapid and critical evaluation, with participation by scientists in all countries, of scientific research relevant to policy choices; and economic growth.

However, a gap between have and have-not nations is still widening in the emerging

Information Age. Unless the developing nations have basic Internet connectivity, these nations will slide increasingly behind.

As the attached map illustrates, basic Internet connectivity already is available to scientists in many nations. However, there are unconnected countries and regions, and we recommend that high priority be given to secure links for sub-Sahara Africa, Central Asian Republics of the former Soviet Union, and other countries that face unusual economic burdens in providing affordable Internet connections to support scientific research.

Recommendation 1:

UNESCO should endeavor to make Internet connectivity available to scientists in all countries at the lowest possible rates.<2>

A. We recommend that UNESCO take a leading role to articulate the common goal of Internet connectivity for scientists in all countries and assure the necessary coordination among UN agencies and other organizations with an interest in this problem. (This recommendation includes the recognition that the United Nations might secure the most favorable rates by, itself, becoming the initial contractor for such services.)<3,4>

B. Concerning payment for these connections: We are impressed by the interest of many intergovernmental, government, and scientific organizations and foundations to assure Internet connectivity in Africa and the former Soviet Union. A wide range of organizations also might use the new Internet connections to reduce the costs of their current programs. A degree of leadership by UNESCO could help everyone to work together, with a common plan and sharing of costs, to achieve their goals quickly and efficiently. Thus:

(1.) To assure leadership and achieve this result quickly, we recommend that a knowledgeable individual with a high degree of technical competence be appointed at a senior level within UNESCO and the UN system.

A formal advisory panel should be convened by the Director- General; a rigorous technical and economic analysis undertaken; and a serious budget should be prepared. The preparatory work should include site visits to African and other developing countries, and consultations should be undertaken with other organizations to develop the plans for cooperative action.

(2.) Cost-sharing by recipient countries is an important principle to maintain. A formula should be developed by which any subsidies diminish as GDP/capita in the recipient country grows, and the costs of the services decline.<5>

The Internet is a tool for communication and the efficient use of global resources, not a solution. The scientific benefits that can be achieved by Internet connectivity will depend both upon the existing resources that can be shared in electronic form, and upon the boldness and imagination with which individual scientists and many organizations can work together to develop new resources and services. The following sections address these issues:

II. Basic Internet Resources

The basic requirement for scientific research is the ability of scientists to search, and obtain copies of, existing scientific literature. What is often a flood in the United States and a few other developed countries is a trickle elsewhere in the world. And the cost of publishing, transmitting, and storing all of this literature - still increasing at an exponential rate - in

traditional printed form has reached the point where it is an inefficient use of resources everywhere. Thus, we recommend:

Recommendation 2:

UNESCO should assure the necessary leadership to effect a rapid global shift to electronic publication of scientific research.

A. Since electronic publication of scientific articles is affordable and will increase availability for all scientists, this form of publication (as well as electronic archiving) should be adopted as widely and quickly as possible. We recommend that the Director-General identify the barriers to this global shift to electronic publishing in science and work with leaders of major scientific societies, scientific publishers, and representatives of major governments and other supporters of scientific research, to remove them.

B. For earlier scientific publications and other material not (yet) available in electronic form, we recommend that UNESCO consult with leading libraries, and others, willing to provide forms of affordable global access; and also explore CD-ROM publication and other alternatives that contribute to a provisional solution of this aspect of the problem. C. UNESCO should broadly encourage Internet-linked electronic archives and international indexing standards for the deposit and on-line retrieval of manuscripts from individual scientists, and for the scientific publications of UNESCO and other science-related organizations.

III. Strategic Planning for Scientific Innovation

Full global access to the scientific literature is basic. After this is assured, a wide range of new resources and services also can improve the scientific benefits of the Internet. For example:

- forums for professional discussion among peers and electronic scientific publishing with different levels of peer review;
- coordination among libraries to create a virtual global library;
- technology that can assist readers to translate scientific journals that are published in electronic form;
- the televised transmission of scientific conferences that expands participation and removes barriers imposed by time and money;
- research colloquia, on a continuing basis, are not geographically constrained;
- distance learning, and the development of a virtual global university.

Any, or all, of these resources and services may be beneficial - perhaps spectacularly so. At this time, there is not yet sufficient experience to select global priorities from this list.

However, we believe it is timely to begin experiments and prototypes, in specialized areas of scientific research, where creative uses of the new global capabilities provided by the Internet may accelerate progress. To plan strategically for the future of the global scientific community - i.e., to accelerate the rate of scientific, medical, and industrial innovation; and achieve progress in economic growth and other urgent global problems - it will be useful to apply the tools of science and devise experiments that specify objectives, assess the causal pathways and resources that help people to produce good results, and learn lessons from experience.

These experiments are, we believe, best designed by scientists and research institutions themselves against the background of the projects for full global connectivity and access to scientific literature that will be underway. At this point, we expect to continue our initial discussions concerning startup projects and experiments in at least the following areas related to public health in both the underdeveloped and developed world <6>:

- Malaria research
- Polio elimination
- genome-mapping research
- emerging diseases
- high priority diseases identified by WHO

However, there may be many urgent areas where new resources, services, and scientific benefits of global connectivity will be immediately obvious. We recommend that:

Recommendation 3:

After projects are underway to meet the priorities discussed above, UNESCO should initiate a review its current programs, and work with other UN science-oriented agencies, to identify and develop Internet uses and resources that accomplish United Nations objectives more efficiently.

Footnotes

<1.> We draw to your attention the recent historical overview and report from the National Research Council, Realizing the Information Future: The Internet and Beyond (Washington, DC: National Academy Press, 1994).

<2.> In this Report, we will use "scientist" to mean all science- trained professionals, including academic research scientists and educators, physicians, engineers, and others whose contributions to their societies depends upon their own ready access to scientific research.

<3.> The ITU/UNESCO study, "The Right to Communicate - at What Price? Economic Constraints to the Effective Use of Telecommunications in Education, Science, Culture and in the Circulation of Information," Document 4-E of the World Telecommunication Development Conference in Buenos Aires (March 21-29, 1994) (Xerox: March 15, 1994), suggested that potential international users should organize themselves to bargain for lower prices.

We note that the international scientific community is not yet sufficiently organized to make such collective bargaining a viable alternative in the near future. In effect, UNESCO may be the most important vehicle for such representation at this time. And access to concessional UN rates can facilitate the result more quickly. (The development of strong user communities can be anticipated from this technology, especially with UNESCO's initial leadership.)

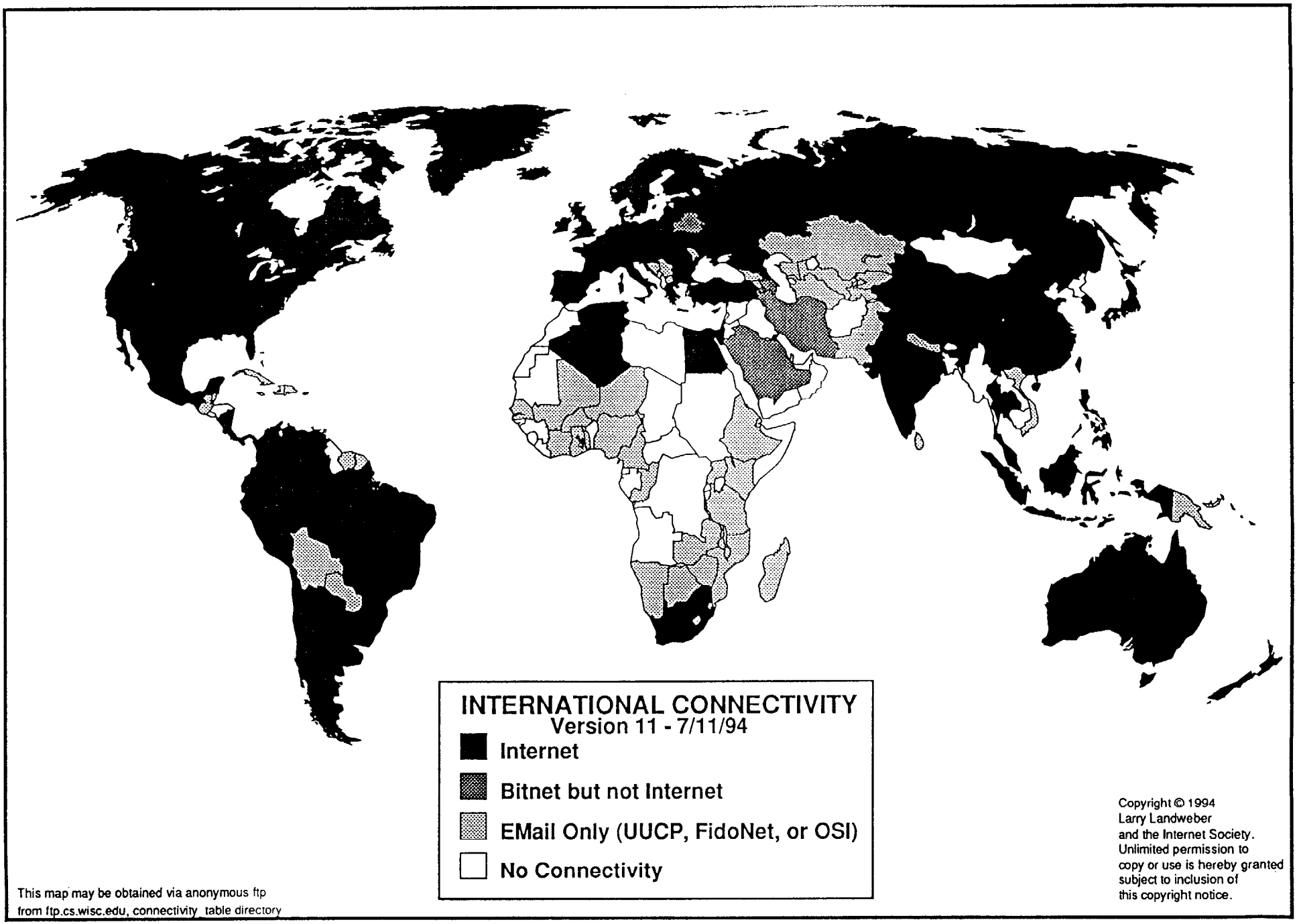
<4.> In response to your earlier inquiry: we make no recommendation concerning the appropriate technology. Indeed there may be no single answer applicable to all sites. Internet connectivity can be provided via INTELSAT communication satellites directly to dish antennas; via standard telephone lines or new fiber optic cables; transmissions over traditional television, radio and microwave frequencies; the new low-earth- orbit satellites using current or new cellular technology; and other methods.

Whether these connections should be managed as a single system with a specific UN-related name (e.g., UNESCO-NET), or simply purchased from a variety of vendors, is partly a technical question. The elements of any new capabilities (e.g., for Africa) do not need to be physically connected together, or managed as a single entity, so long as each of the components is, itself, electronically linked to the Internet.

- Concerning a UNESCO (video) Channel: the Internet is now becoming capable of carrying television signals to specific computer addresses and interactive videoconferences. Thus, UNESCO's own conferences, training programs, and other material that might traditionally be transmitted over a television channel can be multicast over the Internet. This only requires that the Internet connection be sufficiently large to accommodate the volume of material it will carry. There is every likelihood that substantial multimedia programming in support of science and technical education will be elaborated within the evolution of the Internet community; many experiments already are underway.

<5.> If UNESCO helps to underwrite Internet scientific linkages in a country, we believe this relationship should include the expectation that a country is joining in a new level of partnership in the international scientific community. We recommend that, in return, appropriate national scientific journals, government publications, and other pertinent national materials should be made available on the Internet in electronic form.

<6.> These high priority experiments partly reflect judgments based upon the expertise of the participants. We do not intend to pass a comprehensive judgment on the range of focused experiments that might be designed (e.g., selected from environment-related research, common policy problems of applied engineering and technology assessment, etc.)



This map may be obtained via anonymous ftp
from ftp.cs.wisc.edu, connectivity_table directory

Appendix B - List of Participants
(June 8 - 10, 1994)

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